Dynamics of Point Defects in Si

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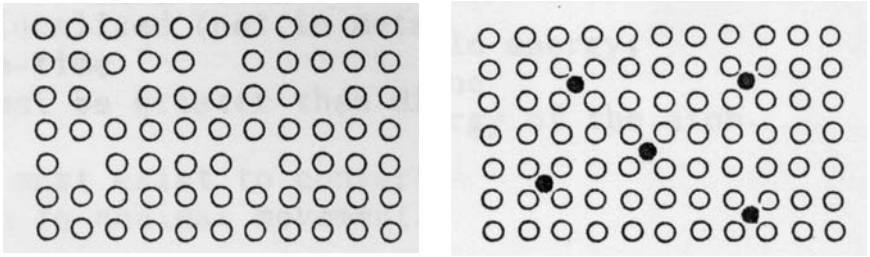
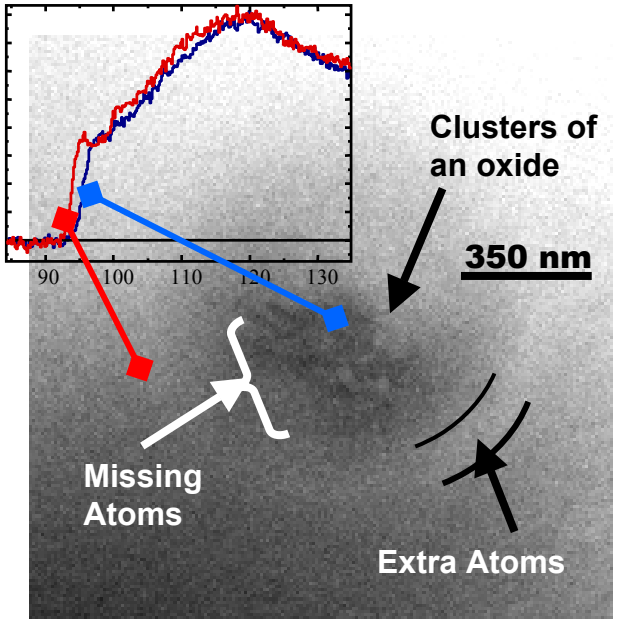
Crystalline silicon for microchips and solar panels is the purest material in the world. However, its electrical performance can be impacted by individual missing atoms (vacancies) or extra atoms (interstitials) in its lattice. We have created tiny aggregates of these defects in a controlled fashion inside an electron microscope where they can be imaged, spectroscopically identified, and manipulated by the e-beam. Our electron microscope images show an area where these defects have been introduced by a 400nm diameter e-beam. Comparison with ab-initio calculations and simulations show that there is clustering of the point defects.



Schematic of missing atoms (left) and extra atoms (right) in a crystal. Detection of these defects is difficult because of their size and low density.



Z-contrast Microscope image of central 400nm e-beam irradiated region. Atoms move outward (white halo), while vacancies remain behind (dark core), as characterized by inset spectra.

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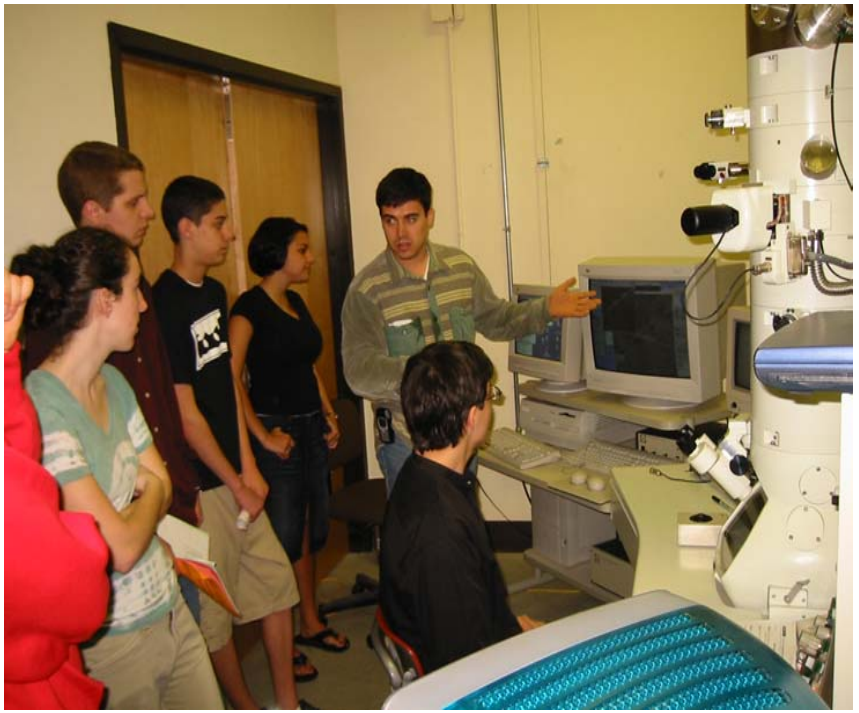
Education: Nathan Stoddard discovered the vacancy / interstitial / impurity complex phenomena (Previous Figure) while doing a semester project in his graduate level electron microscopy class two years ago. It has evolved into his PhD thesis project. Undergraduate NSF-REU student Joseph Markell worked with post-doc Abdennaceur Karoui to further characterize the same material. Markell entered graduate school this Fall. Additional diagnostics have been performed by our students at NREL, the NCEM at Lawrence Berkeley Labs, and ORNL.

Outreach: Graduate and under-graduate students (see Figure at right) explain crystal structure,



crystallographic orientations and defect imaging to high school students during an open house for prospective students, who then operated the TEM and shot their own electron micrographs.